Univ. of Michigan
General Library.O#66688
Ann Arbor, Mich.

MAY 6 1958

EDUCATION LIBRARY

The American Biology Teacher

APRIL, 1958 VOLUME 20, No. 4

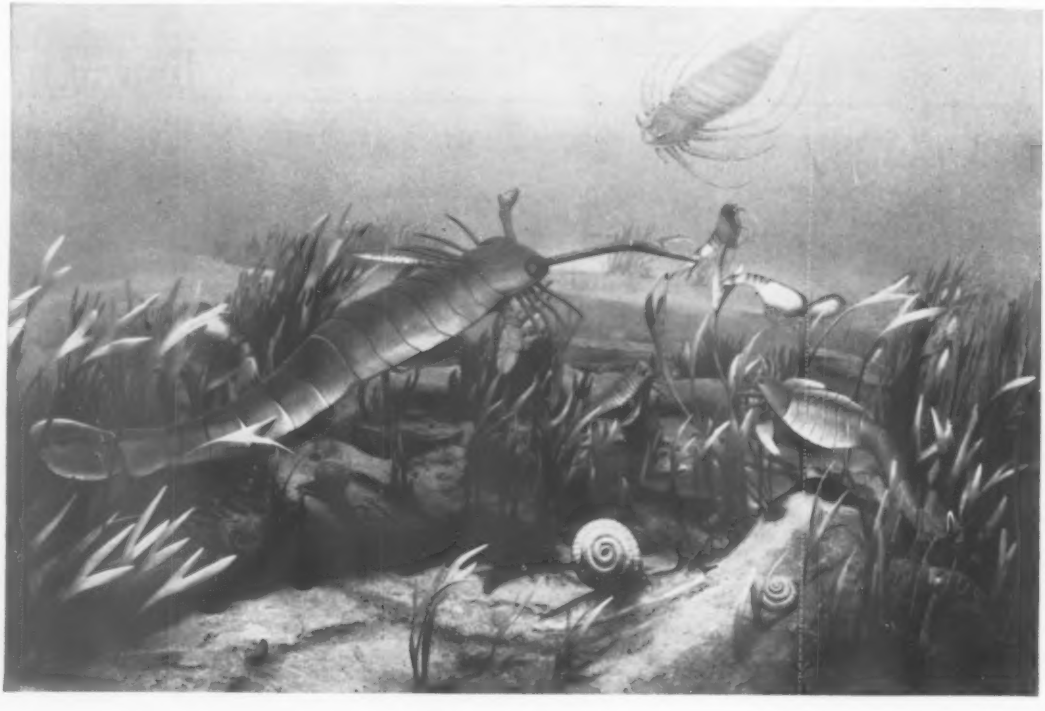
Limnology in High School

Soil Studies in High School

Corners of the Shore

Turtox offers

Colored Diorama Slides of Fossil Invertebrates



These 2 x 2-inch lantern slides are Kodachrome color transparencies of dioramas of prehistoric plants and animals on display in the Chicago Natural History Museum (formerly Field Museum of Natural History) in Chicago. The series consists of 9 slides of fossil invertebrate dioramas, one slide of the restoration of a coal-age swamp forest, and one slide of a diorama of early Tertiary fishes.

Set 46MT3 of 11 lantern slides, as described above.....$10.20

Write for new illustrated pricelists of many additional color slides of Chicago Natural History Museum exhibits distributed exclusively by Turtox

FOR THE BIOLOGICAL SCIENCES
TURTOX PRODUCTS

GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
8200 South Hoyne Avenue, Chicago 20, Illinois

The Sign of the Turtox Pledges Absolute Satisfaction

TABLE OF CONTENTS

Physical Limnology in High School Biology 111
John C. Ayers

Biology in the News 120
Brother H. Charles, F.S.C.

Improving the Teaching of Evolution 121
W. H. Johnson

Corners of the Shore 122
Joseph L. Parkhurst, Jr.

Soil Studies in High School Biology 124
H. Seymour Fowler

Lakeview Elementary Pupils Visit the Biology Lab 128
Mary D. Creager

Poster Projects 130
James E. Jenkins

An Insect and Leaf Drying Press 131
Geraldine V. Marker

Preparation of Kansas High School Teachers of Science 132
Weldon N. Baker and Merle E. Brooks

Books for Biologists 133

Cover Photograph

The first "breath of Spring"—squirrel corn, *Dicentra canadensis*. Photograph by Dr. Joseph M. Riedhart, Coto Research Station, Costa Rica.

THE AMERICAN BIOLOGY TEACHER

Publication of the National Association of Biology Teachers.

Issued monthly during the school year from October to May. Entered as second class matter October 20, 1954, at the post office at Danville, Ill., under the Act of March 3, 1879.

Publication Office—Interstate Press, 19 N. Jackson St., Danville, Ill.

Co-Editors—RICHARD ARMACOST, Department of Biological Sciences, Purdue University, West Lafayette, Ind.; PAUL KLINGE, Coordinator for School Science, Indiana University, Bloomington, Indiana.

The Purdue University address will be the official editorial office. Manuscripts and all publication material may be sent to either of the Co-Editors.

Managing Editor—MURIEL BEUSCHLEIN, 6431 S. Richmond, Chicago 29, Ill.

Subscriptions, renewals, and notices of change of address should be sent to the Secretary-Treasurer, PAUL WEBSTER, Bryan City Schools, Bryan, Ohio. Correspondence concerning advertising should be sent to the Managing Editor.

Annual membership, including subscription, $3.75, subscription to Journal, $3.75, individual copies, $.50, outside United States, $4.50, individual copies, $.50.

Specify DIFCO *. . . the only complete line of microbiological reagents and media*

Culture Media
Microbiological Assay Media
Tissue Culture and Virus Media
Serological Reagents Antisera
Diagnostic Reagents
Sensitivity Disks Unidisks
Peptones Hydrolysates Amino Acids
Enzymes Enrichments Dyes Indicators
Carbohydrates Biochemicals

•

60 years' experience in the preparation of Difco products assures
UNIFORMITY STABILITY ECONOMY

•

Complete Stocks Fast Service 24-hour Shipment

•

Difco Manual and other descriptive literature available on request

DIFCO LABORATORIES
DETROIT 1, MICHIGAN

MEMBERSHIP APPLICATION

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

Name_____
(Please Print)

Address_____

_____

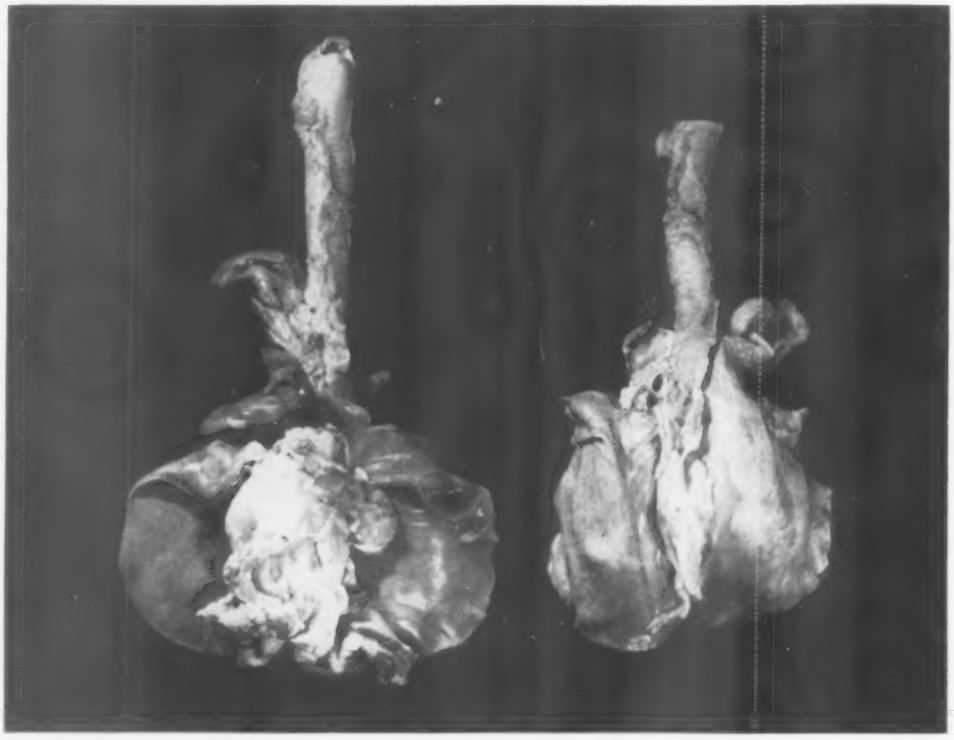
Dues: $3.75 a year, including subscription to

THE AMERICAN BIOLOGY TEACHER
For one year (8 issues)

Send application to:

Paul Webster, Secretary-Treasurer
Bryan City Schools, Bryan, Ohio

Better Preserved Material Is Now Available for Lung and Heart Studies



The lung and heart together which we call the light is excellently portrayed in material prepared from young lambs. The lungs are well embalmed and the entire specimen is well preserved in formalin.

Each, in less than dozen lots	$ 1.50
Per dozen	$ 15.00
Fifty	$ 60.00
Hundred	$119.00

You may want the lungs and trachea separate from the heart. In that case you can order them separately or you can order lungs or hearts whichever you desire.

The Plain Sheep Heart

Individually packaged in a round quart glass jar.
50¢ each, $5.00 per dozen, Fifty for $20.00, $39.00 per hundred.

Bulk packaged in wide mouth gallon jars.
40¢ each, $4.00 per dozen, Fifty for $16.00, $31.00 per hundred.

The Lungs and Trachea of the Sheep

The lungs are embalmed and well preserved. Each in less than dozen lots 50¢, $5.00 per dozen, Fifty for $20.00, $39.00 per hundred.

Any of the above described specimen materials can be had in a fresh frozen condition delivered to you fresh anywhere in the Continental United States. Specimen materials that are fresh cost 25% more than preserved specimens.

Containers and shipping charges are extra and will be added to your invoice.

ALL MATERIAL CARRIES A 100% GUARANTEE.

BIOLOGICAL RESEARCH PRODUCTS CO.
243 West Root Street, Stockyards Station
Chicago 9, Ill.

Physical Limnology in High School Biology

JOHN C. AYERS

Great Lakes Research Institute and Department of Zoology, University of Michigan

INTRODUCTION

Water occupies about 73% of the earth's surface. Life appears to be about as abundant in water as on land; hence about 73% of biology is aquatic biology. The biological drama in water is the same as on land, but the roles are taken by different players. "Hamlet" played in English by a Japanese company would be at once the same as, and different from, "Hamlet" done by a British troupe. The student who had seen both would be more apt to have obtained the play's essence than would one who had seen it done by two English companies. In like manner, the similarities and differences between aquatic and terrestrial biology offer a two-fold approach to many of the biological principles, with correspondingly increased chance that the student will grasp the principles.

Several aspects of aquatic biology are well suited for inclusion in the high-school biology course. Aquatic organisms can be collected year round, are, in general, easily kept, and lend themselves well to physiological and behavioral experiments. The small space requirement for work with these organisms is an obvious advantage. The minimal amount of equipment needed for work with these organisms will find favor with budget-minded administrators. The gadgeteering needed may be the opening wedge in the stimulation of mechanically-inclined students.

To indicate all the possible uses of aquatic biology in one article is obviously impossible. A few illustrations of widely applicable techniques are all that can be given. Variations and modifications of these basic projects will suggest themselves, and, it is hoped, will be suggested by the students. The physical characteristics of the aquatic environment provide the bases for a number of classroom exercises, field trips, and talks by local or state experts. Considerations of the physical environment provide direct leads to biological principles, require no specialized knowledge of aquatic taxonomy, and such special information in physics or chemistry as may be needed can be obtained from the school physics or chemistry teacher.

Some Classroom Experiments

I. *Photosynthesis and Related Matters*

A. Materials:

Water or jelly glasses, distilled water, liquid plant fertilizer, milk, egg white, sugar, salt, half-inch pieces of chalk, teaspoon, tablespoon, eyedropper, cardboard, suspension of green aquarium scum, can of sauerkraut, vinegar.

B. Experiments:

1. Liebig's Law of the Minimum, or limiting factors

The plant nutrients, phosphorus and nitrogen, are needed in small amounts in photosynthesis for they are necessary in the transformation of photosynthesized carbohydrates into the proteins and fats of plant cells. Without P and N, proteins and fats do not form and the plants do not thrive. Plant growth is limited by those necessary factors which are present in suboptimal amounts (limiting factors). The more general law comes from chemistry: a chemical reaction can proceed only until the reagent in minimum abundance is used up (Liebig's Law of the Minimum).

Set up a series of seven glasses, provide each with a cardboard dust-cover, a piece of chalk, ten drops of scum suspension. Fill one glass with distilled water, to others add successively 2 drops, 20 drops, 1 teaspoonful, 1 tablespoonful, 5 tablespoonfuls of the liquid fertilizer and fill with distilled water. Fill the last glass with liquid fertilizer. Grow in window.

The relative amounts of scum growth should show that some P and N are needed, but that beyond this amount growth is not improved. Fertilizers in too great concentration may even inhibit growth. The scum organ-

isms are the "grasslands" of water and are the primary producers of food there, as are the grasslands and cereal crops of land biology. In both, the grasslands are eaten by herbivoes, which in turn are eaten by carnivores or man. Discuss "optimum," "herbivores," "carnivores," food chains; the county Agricultural Agent or a Farm Bureau representative might talk on fertilizers.

2. Pollution

Pollution consists of the presence, in natural waters, of man-introduced foreign materials which either demand oxygen in their decomposition, physically foul the water (clay, oil, etc.), or which are poisonous.

Set up seven glasses, each with chalk, cover, and scum suspension as above. Fill one with tap water, to the rest add successively 2 tablespoons milk, 1 tablespoon egg-white, 2 tablespoons sauerkraut juice, 1 teaspoon sugar, 1 teaspoon salt, 1 tablespoon vinegar and finish filling with tap water. Grow in window for a week. Inspect and smell.

C. Discussion material:

The milk, egg-white, kraut juice, and sugar represent organic materials from creameries, slaughter houses, canneries, tanneries, etc., which have high demand for oxygen in their decomposition processes. They deplete the oxygen of the water and putrefaction results. The salt and the vinegar represent chemical pollutants which are toxic to aquatic organisms. Discuss decomposition in polluted vs unpolluted waters, "oxygen demand," pollution control; the local Game Warden or other representatives of the State Conservation Department could talk on pollution.

A. Materials:

Water or jelly glasses, cardboard, half-inch pieces of chalk, liquid fertilizer, colored cellophane (red, green, blue, and others), cellophane tape, suspension of acquarium scum, eyedropper, watercolors, prism, hotplate, 30 cc. 95% alcohol.

B. Experiments:

1. Influence of light-color (wavelength) on photosynthesis

Tape colored cellophane over the outside of as many glasses as you have cellophane colors. These coverings are light filters which transmit colored light into the glasses, while absorbing light of other colors. Provide each glass with a cover, a piece of chalk, 10 drops of scum suspension, and 10 drops of liquid fertilizer, fill each glass with tap water (boiled, cooled, and aerated if strongly chlorinated). Grow in window.

Relative growth of scum should show that photosynthesis is affected by color of light. Best growth should be in red and blue light with poorer growth in green. Red and blue are absorbed well by chlorophyll, but chlorophyll reflects green light (hence its color) and less light enters the plants to provide energy for photosynthesis.

2. Characteristics of light (preferably done on the day that No. 1 above is checked for results)

Pass sunlight or strong artificial light through a prism; the resulting colors are the spectrum. Point out that mixing all colors of light produces white light. Mix all colors of the water colors on paper. This yields black. Point out that paints and dyes are color absorbers which absorb all colors except one which they reflect and which is seen. Have students hold pieces of colored cellophane to light, repeat with combinations of two colors, with three colors, etc. Combination of all filter (cellophane) colors will absorb all light yielding black. Have students interpret results of No. 1 in terms of light absorption (absorbed light going to provide energy for photosynthesis) and light reflection which means poor growth in green light.

3. Extraction of chlorophyll

Boil a leaf of geranium in water until cooked, transfer to boiling 95% alcohol. Use a hot plate, no open

flame! After a minute in the alcohol remove leaf, note its color and note the color of the alcohol. Have students explain green color of plants in terms of chlorophyll, light absorption and reflection.

II. *Habitat Preference*

A. Materials:

Rectangular glass oven-dishes, panes of window glass for covers, flat-black paint, paraffin, cardboard, cellophane tape, gravel, sand, loam, tea strainer, transparent cellophane, and swimming, creeping or burrowing animals collected from pond or stream.

B. Experiments:

1. Habitat color, light vs dark

Some aquatic animals are influenced by a single factor in their choice of a place in which to live, others choose on the basis of combinations of environmental factors, and still others appear to be more or less indifferent. To assess in the field the bases of "home" choice is a task too complex for high school students. Bringing the animal indoors where it may be given a series of choices of environmental factors can lead to understanding of natural habitat preference. In any case it gives the student a chance to see the scientific method applied. It is impossible to predict the results of these experiments as they will depend upon the animals used. In general, a group of animals collected from several places in a pond will be more satisfactory than those from a single place, and pond animals will be more satisfactory than stream forms.

Determine the lengthwise mid-lines of at least one dish per experiment and paint one half of each dish black on the outside, similarly paint one lengthwise half of the glass cover, fill the dish with tap water or pond water, introduce some of the animals, and cover the dish. Set with one end toward the light and allow to remain overnight. Inspect; classify the animals as dark-loving, light-loving or indifferent.

2. Habitat color with cover (hiding place)

In a dish or dishes prepared as above immerse wads of crumpled transparent cellophane and weight down with clean pebbles. The clear cellophane will provide cover without coincident darkness; animals which seek cover purely out of a "need" to touch something will be indifferent to dark vs light; those preferring both tactile satisfaction and darkness will choose accordingly.

3. Habitat color with substrate choice

In a dish prepared as in No. 1 above, place crosswise dividers to partition it into thirds. Make dividers of paraffined cardboard snugly fitted and held in place by cellophane tape beginning an inch above the dish bottom and extending up to the rim. Cover the bottom of an end compartment with an inch of clean gravel, cover the center portion with an inch of clean washed sand, and put an inch of clean silt in the third. Obtain the silt by stirring a half-pail of loam with a half-pail of water, let settle two hours, pour off water, spoon silt into dish, and again let settle for two hours after filling dish with water. If necessary siphon off the water of the silt compartment and replace with clear water. Remove the partitions gently, introduce the animals and let set (end to light) overnight. Classify the animals on their preferences. It will be necessary to sieve out burrowers with a tea strainer after the others have been classified.

4. Habitat color with substrate and cover choices

A self-explanatory combination of Nos. 2 and 3 above.

5. Additional experiments possible

Substitution of various colors of cellophane for the black paint will allow analysis of "dark" in terms of actual color.

C. Discussion materials:

Discuss "camouflage," "protective coloration," functions of cover, compare aquatic cover to cover in wildlife management; representative of State Conservation Department could talk on wildlife management.

III. *Lake Model*

A. Materials:

Glass oven-dish, or refrigerator hydrater, 2% salt solution colored red with water color or cake coloring, rubber tube with screw clamp, electric fan or vacuum cleaner, ink, potassium permanganate crystals.

In summer, lakes develop a density stratification as a result of input of heat from the surface; winds mix the surface layers, and the result is an upper layer which is warm (less dense) and well oxygenated. Below this is a layer in which density increases (as temperature falls) rapidly, the thermocline. Beneath the thermocline is a region of colder denser water which is shut away from the atmosphere by the upper layer (epilimnion) and thermocline. In this lower region (hypolimnion) decomposition of organic materials uses up oxygen and liberates plant nutrients. If the lake is shallow, muddy, and warm, the hypolimnion may become devoid of oxygen, anaerobic decomposition may go on, and hydrogen sulfide may be produced; since the latter is poisonous, fish and other organisms are driven out, devise means of resistance, or are killed. In cold deep lakes the hypolimnion retains oxygen throughout the summer. In such lakes the cold-loving fishes move into the hypolimnion in summer.

Fill the dish one-third full of clear tap water, rig a siphon from the dish of colored salt water to the bottom of the oven dish and very gently introduce the salt water below the tap water. It may be desirable to try this in private prior to attempting it before the class. The two-layered preparation represents a lake in summer, clear water epilimnion, colored water hypolimnion and the interface between them the thermocline.

B. Experiments:

1. The summer lake circulation

Blow the "wind" from a fan along the length of the dish. Allow a few minutes for the effects to develop. Under moderate winds the thermocline tilts downward at the downwind end and upward at the upwind end as surface water is moved downwind and accumulates. If the wind is moderate the thermocline will not reach the surface at the upwind end. Adjust distance of fan. In the epilimnion, circulation consists of downwind flow at the surface and upwind flow above the thermocline. In the hypolimnion there is upwind flow below the thermocline and downwind flow along the bottom. Small drops of ink dropped into the epilimnion will show the former; crystals of potassium permanganate dropped to bottom will show the latter. The bottom circulation does not always show well.

2. The summer storm

Blow "wind" strongly enough to raise thermocline to the surface at the upwind end. You may need vacuum cleaner. This elevation of subsurface water to the surface is "upwelling" and results in cooling of the epilimnion. At the opposite end "sinking" is taking place; this warms the hypolimnion. Small waves may develop on the thermocline where mixing is going on most strongly. Do not let this experiment run on too long as it will mix away the density difference eventually.

3. The internal seiche (rhymes with "fresh")

At the end of experiment 3 turn off the wind. The resulting oscillation of the thermocline duplicates an oscillation common in lakes at the cessation of wind. To a lesser extent it may be possible to observe the water surface undergoing a similar but smaller and shorter-lived oscillation. LOOK FOR THIS FIRST; this is the surface seiche.

4. The fall turn-over

During the fall, shortening days, lowered altitude of the sun, and longer cooler nights remove heat from the epilimnion. The thermocline becomes weaker and moves nearer to the surface as this process goes on. Theoretically, when the surface water reaches

its maximum density at 4 degrees Centigrade (39.2° Fahrenheit) convection currents will develop as the denser water sinking from the surface to bottom and and displaces the hypolimnion. This top-to-bottom turnover is one of the two times in the year when the hypolimnion of lakes receives its renewal of oxygen and cold water. A similar process, the spring turnover, takes place in spring as the ice cover melts and the surface water warms up to 4° C. Otherwise the hypolimnion is shut away from atmospheric oxygen and sources of cold water for the rest of the year. In nature strong storm winds mix the lake before convection gets a chance to do so.

Stir the waters in the dish until there is only a little clear water left in the surface layer. Blow a strong "wind" along the surface until the color (temperature and density) is uniform. Drop in ink or permanganate and note that there is now only one circulation involving the entire depth.

C. Discussion Materials:

Discuss temperature's relation to density; point out water's unique maximum density at temperature above freezing; discuss how oxygen gets to hypolimnion during turnover (dissolves in the water at the surface); discuss effect of oxygen depletion on fish and other bottom life; discuss the speed at which oxygen depletion comes on (slowly) and what responses the organisms affected by it might make in order to survive or move out such as resistant plant spores; discuss where cold-loving fish should be fished for in 1) a deep cold lake in summer, same lake in spring, same lake in fall, 2) shallow warm lake in summer, spring and fall, 3) discuss where warm-loving fish such as sunfish or largemouth bass should be fished for in both lakes in these three seasons. Discuss why plantings of lake trout are frequently unsuccessful in muddy lakes. They are cold-loving fish with high oxygen requirements. Discuss why plantings of bass in either type of lake are usually successful. They are heat-loving and cold-tolerant. A representative of the State Conservation Department could talk on fish-stocking and fishery management.

Some Field Trips

I. *Stream Field Trip*

A. Place:

A stream where fast water and a pool are close together.

B. Materials:

Shovel, window screen about two feet square, two quart milk bottles with caps, ruler, wood scraps, 10-foot measured fish line or cord, watch, minnow seine or scrim window curtain with stout sticks at ends, chemical thermometer, formalin (10% formaldehyde solution), mason jars, paper labels, notebook.

C. Procedures in both fast and slow water:

1. Determine current velocity near center of the stream by the time needed for a wood scrap to drift 10 feet. Record velocities.

2. Place a cupful of bottom sediment in a milk bottle, fill bottle with water, shake vigorously with a hand over top, set on ground, after 4 minutes make measurements 2, 2a, and 3 (indicated on Figure 1). Teacher makes measurements 1 and 4 two hours after collection. Take reasonable care that the bottles are not reshaken in getting them back to school. Used milk bottle caps will make adequate stoppers. Calculate the percentages of gravel which is measurement 3 divided by measurement 1, of sand (2 plus 2a divided by 1), of silt (4 divided by 1). Compare these percentages from fast and slow water. Record the two sets of percentages.

3. Determine surface and bottom water temperatures in fast and slow water. Use the water-sampler shown in Figure 2 for bottom water samples. Hold bottle near bottom for a minute before removing cork to let bottle assume bottom water temperature. Remove cork, pull up bottle, insert thermometer and read temperature. Record all four temperatures.

4. Seine edge of fast water, with no disturbance of bottom other than drag of net. Remove catch to mason jar and drop in a label.
5. Seine again over the same bottom but this time with shovelling of bottom in front of net. Remove catch to mason jar and drop in label.
6. Seine without disturbance in slow water. Bottle catch and label.
7. Seine with shovelling in slow water. Bottle catch and label.
8. Screen equal amounts of sediments from fast and slow water. Place sediment in center of screen and let center sag into running water while edges are held up. Bottle catches and label.
9. Observe types and relative numbers of rooted aquatic plants in the two waters. Collect representative plants from each, bottle and label.

D. Discussion and study material:

Fine sediments are eroded out of bottom in fast water and settle in slow water.

Current usually mixes away temperature differences, though local sun or shade can effect temperatures in pools.

Weakly-swimming animals are swept out of the fast-water areas but remain in slow-water areas.

Streamlined strong swimmers are characteristic of fast water.

Clinging devices are common in bottom forms of fast water.

Soft-bodied burrowing forms are almost entirely from the soft sediments of slow water.

Cover in fast water is primarily the interstices of the bottom.

Cover in slow water is both the burrowable soft bottom and the aquatic plants.

Greater volume of aquatic plant cover in slow water, usually.

Fewer plants and removal of fine sediments usually mean that fast water is a lighter-colored environment than is the slow water.

Inspect fast-water organisms for clinging devices; look for them in the slow-water forms.

Note: Unless the weather is hot, the animals collected will live over night in an open mason jar. If in doubt of their living, preserve with enough formalin to give an odor to the water.

II. *Lake Field Trip*

A. Place:

A lake with sandy shore where deep water is available in a reasonably short distance.

B. Materials:

Chemical thermometer, Secchi disc (Fig. 3), coke-bottle water sampler (Fig. 4), nylon plankton-net (Fig. 5), milk-bottle soil analyser (Fig. 1), bucket bottom sampler (Fig. 6), pressure indicator (Fig. 7), clothes-line, chalk-line, wire, long slender rubber balloon, test tube or olive bottle, scrap lumber, string, bricks with holes.

C. Apparatus:

Secchi disc: Pass an eye-bolt through the center of an 8-inch circle of sheet metal and secure with washer and nut. Pass the chalk line through a six-inch pipe nipple and tie to the eyebolt. Pipe provides extra weight. Paint the disc flat white and mark the line with daubs of India ink or paint at each foot.

Coke-bottle water sampler: Obtain a brick made with three rows of small holes in it, wire a coke bottle to the side of the brick as in Figure 4. Attach a wire loop at top and tie on clothesline. Supply the bottle with a cork which fits only tightly enough to avoid its floating out, drill a hole through the cork and tie a chalk-line passed through the hole around a segment of nail no longer than the width of the cork, and pull nail firmly up against bottom of cork. This line is the cork-pulling line. Difficulties with jamming of the cork can be avoided if a narrow V-shaped cut is made along the length of the cork; this will allow some leakage of water into the bottle to ease the pressure difference encountered at depth. The leaked water will come to the temperature of the surrounding water at the time the bottle does.

Nylon plankton-net: Insert the top

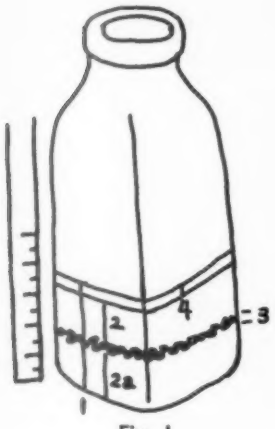


Fig. 1

Fig. 2

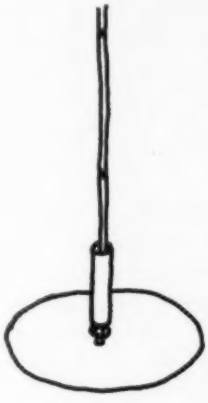


Fig. 3

Fig. 4

Fig. 5

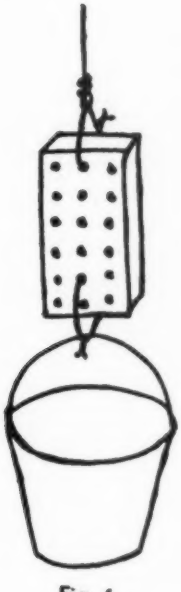


Fig. 6

Fig. 7

of a lady's nylon stocking between the two parts of a metal embroidery hoop. Space three 12-inch pieces of chalk-line equally around the rim of the hoop; pass each through the stocking top and tie around the hoop; join the three pieces to a key-ring and adjust their length until the hoop hangs horizontally; tie a long length of chalk-line to the key-ring as a towing line. Cut from the toe of the stocking enough material to make a hole into which a baby-food jar will fit snugly. Tie the jar in with a piece of string. Figure 5 shows the completed net.

Bucket bottom-sampler: Fasten a bucket to a brick by a wire loop as in Figure 6; attach a clothes-line to a wire loop at the other end of the brick.

Pressure indicator: Introduce a long slender balloon into a test tube or olive bottle and inflate it until it fits tightly in the container and has an expanded portion outside the con-

tainer mouth; fasten with string or a rubber band. Obtain a piece of 1″ x 3″ scrap lumber 18 inches long and provide the upper end of the wood with a hole for attachment of a clothes-line. Near the upper end of the wood drive two nails and stretch two rubber bands between them. Wire the test tube or olive bottle near the bottom end as in Figure 7. Tie a piece of string around the neck of the balloon. Insert a pencil between the rubber bands at the upper end of the board. Slide the pencil down until the bands are near the middle of the pencil; adjust the bands until they hold the pencil when the board is vertical. Remove the pencil; cut a groove around it near one end; replace it between the bands; tie the string from the balloon neck into the groove. Wire the board to the side of a brick and test to see if one brick will sink the board; if not, or if the board sinks in other than a vertical position, wire another brick to the lower edge of the board. In the field, slide the pencil upward until the string to the balloon is taut. With a knife-point or other pencil dent the pencil where it emerges above the rubber bands, and measure the diameter of the exposed bulge of the balloon. Water pressure will shrink the balloon and draw the pencil down to a new position. After lowering the indicator, mark the new position of the pencil, and measure the distance moved. The maximum pressure encountered by the indicator can be calculated from 15 : (D—A) :: X : D where 15 is 15 lb./inch^2 air pressure, D is the diameter of the exposed portion of the balloon, A is the inches moved by the pencil, and X is the water pressure in lb./inch^2. A small error caused by shrinkage of the balloon from lower temperature is involved, and the pressure calculated will be too great by a small amount. This can be calculated, if desired, from the air temperature, the diameter of exposed balloon, the deep water temperature, and the Gas Laws.

D. Field procedures:

1. Lower the Secchi disc in deep water until it disappears, bring it up until it reappears, decide on and record the color of the water above the disc, and read from the marked line the depth of disappearance. Divide this by 3.3 to convert to meters, and multiply by 2.7 to obtain the compensation depth at which there is only enough light to enable photosynthesis to make enough plant tissue during the day to replace that oxidized in plant respiration during the night.

2. Read air temperature and surface water temperature. Lower the water sampler to 5 feet, pull its cork and hold it there for a minute, and bring up and insert thermometer. Similarly take the temperatures at 10, 15, 25, 35, etc., to bottom. If the cork jams under the water pressure at greater depths, remove it, fill the bottle with surface water, lower quickly to depth, and hold for three minutes while convection replaces the warm surface water with water from the desired depth. A series of knots at five-foot intervals along the clothesline will facilitate depth determination. Class can graph temperature against depth as the data come in. From their graphs they should be able to locate the thermocline.

3. Lower the plankton net to bottom, let set a minute, draw up steadily at moderate speed, splash water onto stocking to wash plankters down into jar, and remove jar and label "vertical tow," cap jar. Rinse stocking by swishing in water, tie on another jar, and holding net at the surface row slowly around for 3-5 minutes, rinse, remove jar, label "surface tow" and cap. Organisms present in the vertical tow, but absent from the surface, are inhabitants of the deep water. Some of these may rise to the surface at night if they are merely photo-negative, or may stay in the depths all summer if they are temperature-limited.

4. Lower the bucket bottom-sampler to the bottom and row a few strokes. Bring it gently to the surface and

note whether the sediment is sand or "mud"; analyse a cupful of it in the milk bottle (see stream trip), also smell of the sediment. An odor of rotten eggs will indicate oxygen depletion and anaerobic bottom conditions if present.

5. Adjust the pencil of the pressure indicator, measure the diameter of the exposed portion of the balloon and lower to bottom (do not let it tip over), bring it up, mark the new position of the pencil, and calculate the water pressure.

6. Row ashore and make a soil analysis of the sandy wavewashed sediment along shore. Compare this to that dredged up from the bottom in deep water. Waves wash the fine sediments out of the shore deposits and work them outward to deep water where they settle. Organic detritus from shore is carried out to deep water also. As a result the deeper bottom is softer and richer in organic food materials than is the shore.

E. Discussion and study material:

Light entering the water is scattered out of its vertical path by reflection from suspended solid particles, by refraction around the edges of plankters, solid particles, and water molecules (demonstrate how the edge of a shadow becomes undistinct a short distance from the object), and by absorption by phytoplankton or colored materials. The compensation depth has terrestrial analogies in the fact that some ornamental plants will not grow in shade and that some house-plants will not survive in the shadier portions of the house.

Materials on the epilimnion, thermocline, and hypolimnion as well as on the spring and fall turnovers are given in the lake model project and may be applied here. Water pressure increases at the rate of one atmosphere (15 lb./inch^2) for each 10 meters or 33 feet of depth. Lake Superior has depths of 1200 feet and the ocean of 35,000 feet; compute the bottom pressures which exist. Discuss adaptations of organisms for the withstanding of such pressures, absense of gas-filled cavities, and various devices for letting the pressure get into the bodies.

Microscopic examination of the plankton tows and examination by magnifying glass to determine whether there were forms in the deeper water which were not represented in the surface. If intense interest in identification develops, representative specimens can be placed in vials of rubbing alcohol and sent to your state university for identification. Try to limit the extent of this, as it demands a great deal of time. Students might prefer to try their own identifications out of Needham and Needham. Discuss bottom plankton of oxygen-deficient hypolimnion (absent).

Discussion

It has been my aim to describe some experiments and field trips in physical limnology which lead directly to biological principles and which could be carried by the biology class of any high school. With one exception the materials needed for these projects are items readily and inexpensively obtainable.

Chemical thermometers are not expensive, but they may not be readily available. If not obtainable at the school, one may sometimes be bought or borrowed at a drugstore. A dial thermometer with a stem can be substituted if available and of the correct temperature range. Ordinary weather thermometers can be used if the water samplers are constructed with pint mason jars instead of soft-drink bottles and sawed wooden discs in place of corks. Such thermometers must be very carefully read.

Every effort has been made to foresee and forestall failures, though some may have been overlooked and some failures may occur. The peculiarities of local tapwaters, the particular assemblages of organisms collected, and unusual characteristics of local streams or lakes are factors not foreseeable which may be involved in failures. A good failure offers opportunity for application of the scientific method and generally will be solved by further experiments in which one factor at a time is varied from the original condition.

Summary

Several classroom experiments and two field trips are described, with material lists, procedures, and discussion materials given. These projects are designed to be within the material capabilities of any community and the discussion materials have been chosen to lead directly to biological principles. In most cases there are terrestrial analogs of the aquatic phenomena pointed out here. Comparisons of the aquatic to the terrestrial provide a two-fold approach with increased chance for stimulation of the student.

Selected Reference Works

While not the only good references, by any means, the author has found the following to have been of consistent value.

Iowa Fish and Fishing. J. R. Harland and E. B. Speaker. State Conservation Commission of Iowa, Des Moines, Iowa Plant Physiology. B. S. Meyer and D. B Anderson. D. Van Nostrand Company, Inc., New York.

A Guide to the Study of Freshwater Biology. J. G. Needham and P. R. Needham. Comstock Publishing Associates, Cornell University Press, Ithaca, New York.

Fundamentals of Limnology. F. Ruttner (translated by D. G. Frey and F. E. J. Fry). University of Toronto Press, Toronto, Ontario.

Limnology. P. S. Welch. McGraw-Hill Book Company, Inc., New York.

Elements of Ecology. G. L. Clarke. John Wiley and Sons, Inc., New York.

Biology in the News

Brother H. Charles, F.S.C.

HOW TO HUNT WOODCHUCKS, Dick Drew, *Outdoor Life*, March 1958, pp. 56-59, 122-126.

What an experienced hunter learned about the habits of woodchucks. Much in this article might be used in a discussion on conservation.

SO YOU'RE ALL TENSED UP, Harry J. Johnson, M.D., *Sat. Ev. Post*, March 15, 1958, pp. 23, 127-131.

Administrative responsibilities, irregular living habits and accepting positions for which we are not prepared shorten the active lives of ordinary workers as well as of executives. The article counsels patience, moderation, tolerance of yourself and others.

GREAT TROPICAL GARDEN, *Life*, March 17, 1958, pp. 82-91.

Wonderful color pictures of the Allerton Gardens in Hawaii. Suitable for your bulletin board.

MENACE OF THE HUNGRY SEA STAR, *Life*, March 17, 1958, pp. 136-139.

A short story of the activities of the starfish. The first picture is specially suitable for your bulletin board.

HOW NEUROTIC ARE YOU? John E. Gibson, *Ladies Home Journal*, March 1958, pp. 47-48.

Does doodling indicate anything about your mental balance? This and other questions relative to varieties of neuroses are discussed in a series of short paragraphs.

MENTAL ILLNESS, Dr. Walter C. Alvarez, *Good Housekeeping*, March 1958, pp. 66, 212-215.

Some very common sense information about psychoses and how they should be treated.

HOW SAFE IS YOUR HOSPITAL? Ruth and Edward Brecher, *Redbook*, March 1958, pp. 32-33, 91-94.

Most hospitals maintain very high standards of service. Some do not. This article discusses the standards and gives a list by which you can make a common sense evaluation of the hospitals in your locality.

ABOUT DANDRUFF AND YOUR HAIR, *McCall's*, March 1958.

ABOUT DANDRUFF AND YOUR HAIR, Dr. Frank McGowan, *McCall's*, March 1958, pp. 4, 102-103.

Condensed information about a troublesome condition of the hair and how it should be treated.

ALL ABOUT YOUR THROAT, Evan Wylie, *McCall's*, March 1958, pp. 29, 54-56.

Throat trouble is just as harmful to the human body and causes just as much distress and absenteeism as does the common cold. This article tells you why the throat is often sore and what you may do about it.

Collectors Wanted

The United Scientific Biological Supply House, 200 North Jefferson, Chicago 6, Illinois, is interested in obtaining the names of biologists who would be interested in collecting plant and animal material for them this summer. Anyone interested should write to the United Scientific at the above address, and ask them for their collectors-want list.

Improving the Teaching of Evolution[1]

W. H. JOHNSON
Head of Science Department, Wabash College

My invitation to participate in this panel discussion indicated that I should point out how, in my opinion, evolution could be taught more effectively in the schools and colleges.

When I started to think about this I recalled some conversations which I have had with other biologists in recent years. In one of these, involving the outline which a committee had prepared for the Advanced Placement Course in Biology, I pointed out that evolution was to be the central theme in the course. A visiting biologist replied that he thought that this was a mistake—that evolution was now passe—that we should make some concept such as homeostosis the central theme. In another conversation, a different biologist stated that it should not be necessary today to spend a lot of time on the evidence of evolution. Everyone, or almost everyone, he said, now accepts the concept of evolution.

Now I don't know how many teachers of biology have the point of view of either of these two men, but I am convinced that to the extent that we make the assumptions which these two men made, we will not do a very effective job of teaching the concept of organic evolution. When you analyze the points of view of these two men, one of them was taking the position that evolution is passe, not very important in this day of modern biological developments; the other was taking the stand that since the concept of evolution is generally accepted by educated people, the presentation of the evidence for the concept to each generation of young people is not very important. We can no more assume that each generation of young people is born with the background for appreciating the concept of evolution anymore than we can assume that they are born with an understanding of the atom, or anything else for that matter. To me the principle of organic evolution is the most pervasive of all the biological principles. All aspects of biology are tied together by this principle, and all aspects of biology contribute to an understanding of it.

In the teaching of our basic or introductory courses it is good, from my point of view, to have a culminating section devoted to evolution where we pull the various evidences together and then develop the modern ideas about the factors which have been and are operating in the process. But we need to do much more than this—we need to point out and emphasize the evolutionary aspects of the subject all the way. It may be that the most interesting aspects of the study of evolution today are the considerations of the mechanisms or factors involved in the process. However, no student, in my opinion, is in a very favorable position to appreciate the complexities of the operating factors without a solid background of the supporting evidences from many fields of biology.

It is my contention that we need to emphasize the persistence of basic features in living things throughout the introductory study and continually point out the significance of such persistence to the concept of evolution. When we study protoplasm we find that, although there are some differences in chemical composition from type to type, the basic nature of protoplasm is essentially the same wherever we look. When we study cells, basic units of structure and function of all living things, we find that the basic mechanism of cell reproduction, mitosis, is essentially the same in protists, plants and animals. Also, in all those forms which have sexual reproduction, the process for reducing the chromosome numbers, meiosis, is essentially the same. In cellular respiration, although many modifications are found, the basic pathway for the release of energy is the same in the cells of a great variety of organisms. A hormone from one vertebrate will serve the same function in another. When we talk about vitamin requirements in man and other animals we have the opportunity to point out that these substances function as parts of the metabolic machinery of cells generally—one of the consequences of evolution has been the loss of their syntheses by some organisms.

I have by no means exhausted the possibilities. There are many other places where the

[1]Remarks delivered at Symposium on Teaching the Major Concepts, AAAS Meeting, Indianapolis, 1957.

persistence of basic features may be pointed out in a general course, and through this gradually the student will be impressed with the relatedness of living things.

A consideration of the basis for such persistence and also the basis for the origin of variation is dependent upon a good understanding of basic genetic principles. With some knowledge of the gene and mutation the student has a basis for understanding the origin of variation through mutation and recombination. For an understanding of the incorporation of variations in a species and the ultimate formation of a new type the student must be introduced to the role of the population in evolution, to the forces of selection, to the possibilities of genetic drift and to the nature of isolating mechanisms.

Obviously I cannot comment on all of these in my time limit. I believe that the teaching of evolution is often deficient in the lack of emphasis on the role of the population in the process. As a result of mutation, selection, and sometimes genetic drift, the gene pool of the population is modified and as a consequence nonrandom reproduction results. It is necessary to introduce the Hardy-Weinberg principle. It is also important to bring in the concept of genetic drift—the role of chance in modifying the ratio of alleles, or even of eliminating alleles, in small populations. Moody[1] has described how colored marbles may be used effectively in helping students grasp these concepts.

Any consideration of evolution today that omits reference to the modern ideas about the origin of life is inadequate. Since the publication of Oparin[2] many interesting discussions have appeared. All teachers of biology should be familiar with the article by Wald[3] and the more recent symposium on "Modern Ideas on Spontaneous Generation"[4] held by the New York Academy of Sciences.

Finally, I would like to suggest that many teachers need to refocus their teaching about the evolution of man. That man is a part of the whole story of biological evolution is important and this should be emphasized. However, with the biological evolution of man there has come into existence another kind of evolution—social evolution. This new evolution is a product of biological evolution, but something different from it. Man through his language, is able to transmit the knowledge learned in each generation to the next. Man of all the products of organic evolution, is the one kind of organism able to exercise control over his environment. Dobzhansky[5] has a good discussion of this.

References

1. Moody, P. A. *Introduction to Evolution.* Harper and Brothers. 1953.
2. Oparin, A. I. *Origin of Life.* Dover. 1953.
3. Wald, G. *The Origin of Life.* In the Physics and Chemistry of Life. Simon and Schuster. 1955.
4. Nigrelli, R. F. et al., "Modern Ideas on Spontaneous Generation." Ann. New York Academy Science, 69: 255-376. 1957.
5. Dobzhansky, T. *Evolution, Genetics and Man.* Wiley. 1955.

Corners of the Shore

JOSEPH L. PARKHURST, JR.
Colonia, New Jersey

The shore appears on a map as nothing more than a "fringe" on the ocean, or land, depending on your point of view. It undulates along, extending its foot into the surf and cutting landward to quiet backwaters. It is not just a sandy strip with a few blades of grass; it offers many pockets and corners to explore.

A few blades of grass on a sand dune are only a start on shore grass. The outer dunes along the sand bars separating ocean from bay are occupied by beach grass. Every vacationer knows it. All around bay shores are other grasses just as much a part of the shore scene. Cordgrass wades right out into bays, spreads over salt marshes and grows up tidal creeks. Most striking of this group is big cordgrass, *Spartina cynosuroides* (figure 1). It is just about as high as reeds and slightly taller than cat-tails. In the same brackish marshes are shore rushes, grass-like, having triangular stems. Soft rush mixes with cat-tail and reed.

Behind the marsh grasses and back of the outer dunes are some characteristic shore trees. The same trees that grow straight and tall on the landward side of the bay are stunted and wind-planed on the inner dunes. Bayberry, holly and pitch pine are typical. Cat brier and poison ivy tangles with them.

Many inlets cut through the outer beach letting in some of the sea life. You should ar-

FIG. No. 1 Cordgrass

FIG. No. 2 Wormtubes

FIG. No. 3 Mussel Wrack

range to be around these places when the tide is out. A clam shell, broken bottle or brick (figure 2) under a wharf may be covered with limy white tubes of a sea-worm, *Hydroides dianthus*. A crack in a wharf timber may be hiding the tiniest snails. Tied up fishing boats often contain some sort of interesting small animals.

On the beach there is a tide line with drift, seaweeds and shells. What is washed up and the way it's left will vary with the weather. After a storm the beach is strewn with mussels, which range from big shiny shells to handfuls of little "seed" muscles (figure 3). Heavy surf may rip loose rope and netting threaded with mussels. Little crabs usually come with this mussel wrack.

A look around the tide line always exposes something of interest. On the north side of a bay there are blue mussels; on the other side are ribbed mussels. When the bottom mud has been churned up by rough water the beach is lined with blackened shells. Clam shells are full of neat round holes rasped out by drilling snails. There is a story in these shell heaps.

For those who want something more than grass and shells from the shore, the time to come is late in the spring. Of all shore ani-

FIG. No. 4 Horseshoe Crabs

mals the horseshoe crab puts on the best show. The large size of *Limulus polyphemus* makes their annual spawning exercise something to watch. Bay shores are swarming with these creatures. Males attach themselves to the slightly larger females with a special pair of clawed legs. With a lurching action the mating pairs push ashore, lay their eggs in a large depression and move on. You can spot them pushing around in the wet sand or half buried (figure 4) when the tide has lowered. Many wash up, dry out and die on the beaches. Some are covered on both sides with limpets.

In a few weeks there is evidence that the eggs have hatched along the water's edge. Later the same beaches are lined with casts, or molted shells, of young growing horseshoe crabs as life goes on. With this thought we leave the shore, but only temporarily. There are some other corners we saved for the next time.

WORKBOOK FOR FIELD BIOLOGY AND ECOLOGY, Allen H. Benton and William E. Werner, Jr., 268 pp., $2.75, Burgess Publishing Co., Minneapolis, Minn., 1957.

This book was designed as a companion and guide for those hoping to find pleasure in the observation, study and contemplation of nature. There are sections on taxonomy, field techniques, terrestrial communities and succession, aquatic communities and succession, population and behavior studies, projects and selected literature.

Soil Studies in High School Biology

H. SEYMOUR FOWLER
College of Education,
Pennsylvania State University

It probably seems strange to some persons to think of the study of soils as a part of a high school biology course. However, if we think of ecological aspects in the study of biology, the study of soil becomes a near necessity. If we define ecology as the study of the interaction of plants, animals and their environment, then the study of soil as an important part of that environment becomes imperative. There are numerous other reasons why soil-study should be included as a part of high school biology. Man, in spite of his technological advances and his conquest of space, is, in the final analysis, dependent on his soil resources for his food supply. Man has not been intelligent in his use of this precious resource. Perhaps this misuse or economically unsound use has resulted from a lack of understanding of the resource. If this is true then we as teachers should attempt to do something about the problem. What can we do? We can organize our classes into committees, report on the literature, and talk about soil. This may give our class more knowledge of soil. However, it seems to me, that a better approach is to actually work with the soil first. This entails the development of a number of activities which will give us a greater understanding of, to coin a phrase, "What is this stuff called dirt?" These experiences, I believe, will make soil study much more interesting.

Soil Formation

There are numerous activities which may be used in a discussion of methods of soil formation. Many of these might well be included in elementary science programs. However, since they usually are not so employed; perhaps they should be a part of the high school biology program.

Soils may be formed in place from rocks. One cannot wait for this process to happen so some of the action may be illustrated. Gravity may be an agent here. When rocks

are moved over one another they may break and be ground up. It is possible to illustrate this action with two pieces of loosely-cemented sandstone. To do this, rub the two pieces together and observe the tiny sand grains which are broken from the two rocks. Plants, such as the lichens, show another remarkable characteristic. These tiny plants are able to produce acids which act on carbonates in rocks. This dissolves a portion of the rock aiding in its break-down by other weathering agents. A similar chemical action can be demonstrated by dropping dilute hydrochloric acid on limestone. The freezing and thawing action of water trapped in rocks also helps to break them into smaller fragments which with later other actions may produce soil particles. Some success may be achieved in duplicating this process with porous shale. One needs only to soak the shale for a few hours in water. The piece of shale is then placed in the freezing compartment of a refrigerator for a day. The shale is removed and brought to room temperature. Then the shale is placed in the freezing compartment again for another day. If this routine is repeated for a week or perhaps two weeks one can notice a change in the shale. Cracks become evident along the junctions of the layers. The shale crumbles much more easily than it did previously. This, then, helps to illustrate the freezing and thawing action on rocks. Some of my geologist friends discount this action as being a very important method of soil formation. It must, however, account for some disintegration of rocks.

Soil may also be formed on transported materials. Two methods of transportation of materials are glaciation and wind action. Deposition of materials from glaciers may be illustrated easily. One needs two ice cube trays without dividers, water, and an assortment of sand, pebbles, and a dark colored soil. Fill one ice cube tray about two-thirds full of water. Add the mixture of pebbles, sand, and soil. Repeat this procedure with the second ice-cube tray. Place both in the freezing compartment of a refrigerator. After the mixture has frozen, remove the contents. Place one piece of ice on a light-colored soil. Place the second piece of ice on top of the first. This is your glacier. The glacier may be pushed along the soil surface to show its cutting and gouging action. Then leave the glacier in position and wait until the ice melts. At the location of the ice you can observe the materials which have been deposited. Some of the pebbles left exposed may be compared to glacial erratics.

The great loess soils common to parts of the midwest were carried into their present position by strong winds. Wind action may be demonstrated using a large electric fan and very fine, dry soil. Make a pile of the fine soil on a newspaper at one end of a long table. Direct the current of air from the fan against the dust. Note that the fine soil is moved by the air current. With a little practice in directing the fan's current it is possible to illustrate the same snow-drift-like action present in the deposition of fine wind-blown soil.

Soil Profiles

Another thing which a biology teacher may want to illustrate is a soil profile. If a vertical section downward through a soil is examined, a layering, often well defined, will usually be found. Such a section is called a profile and the individual layers are called horizons. For our purposes let us think of only 3 horizons: we will indicate the top-soil as the A horizon, the sub-soil as the B horizon, and the parent material from which the soil was formed as the C horizon. Biology students should examine a profile and learn to recognize these horizons. The teacher should look for a road-cut to demonstrate soil profiles. After studying the characteristics of the A, B, and C horizons, samples of these should be taken. Two methods work satisfactorily for this purpose. For the first method one needs long strips of white blotters and paste such as that which is used by paper-hangers. A thick layer of paste is applied to one side of the blotter. The paste-side of the blotter is pressed firmly against the face of the profile. The dry side of the blotter is then rubbed vigorously. The blotter is carefully pulled away from the face of the profile. Enough soil will adhere to the paste to make a permanent soil profile sample. After the paste has dried it is possible to keep the soil particles in place with a few coats of lacquer applied from an aerosol-type lacquer applicator.

A second method for taking soil profile samples involves only a narrow bottle such as those in which olives are sold. Fill the bottle one-third full of material from the C horizon

(parent material). Next add material from the B horizon (sub-soil) to fill the second third of the bottle. Complete the filling of the bottle using the A horizon or top-soil. Your sample then is, in miniature, a representation of the soil profile you have been observing.

Physical Properties

There are many physical properties of soil which might be investigated. However, we have only time for the description of a few here.

The compactness of a soil is an important characteristic. By their very nature some soils are more compact than others. Soil compactness may be measured using a device which resembles a pile driver. The base of the device is made from two pieces of 2″ x 4″ lumber fastened together. The completed base has the dimensions: width, 3½″; length, 3½″; and height, 3¼″. The frame of the tester is made with thin strips of wood, each ½″ x ½″ x 33″. These are fastened to the base with screws. Strips of wood, ⅛″ x 1″ x 33″ are fastened to the corners to complete the frame. Each of these strips is nailed in place along and adjacent to each of the larger corner strips. The dropping block is constructed with two pieces of 2″x 4″ lumber. Its dimensions are: length, 3¼″; width, 3¼″; height, 3½″. The lower horizontal surface of this block is covered with galvanized iron. The dropping block is then put in place and allowed to drop to the base. If the block does not fall freely adjustments in the size of the block are made. The top of the tester is made by nailing in place 4 strips of thin wood to complete the frame.

A vertical hole is then made in the center of the base. The diameter of this hole should be such that an 8″ spike moves through it freely. The spike is then marked in ½″ calibrations.

To operate the soil compactness tester, the device is put in place on the surface of the soil to be tested. The pointed end of the spike then rests against the soil surface. The calibration on a level with the upper surface of the base is read and recorded. The tester is held in its vertical position with the user's left hand while the right hand is used to lift the block to its maximum height in the frame. The calibration on the spike in line with the top of the base is read and recorded. The dropping block is released and allowed to fall freely. After it strikes the spike the calibration on the spike is again read and recorded. The distance of penetration per fall can be determined by subtracting the reading on the spike before the block has fallen from the reading on the spike after the block has dropped. This procedure in one location alone is not significant. However, if data from a number of different locations are gathered, one can then make comparisons of the soil compactness in these locations.

The rate at which water penetrates into soils is another characteristic which warrants investigation. This can be done easily using tin cans. One end of a tin can is removed, as is ordinarly done, leaving the rim intact. The opposite end is removed in such a manner that the rim is removed. This leaves a sharp edge. The sharp end of the can is then placed against the soil to be tested. Using a twisting motion the can is pushed into the soil to a depth of about one inch. The can is filled with a given volume of water. The time for the water to penetrate into the soil is recorded. If this procedure is repeated in various locations a comparison of the rate of water penetration can be made.

The rate of water penetration should be related to compactness. If the studies of compactness and water penetration are done in the same locations this becomes possible.

The author once conducted what proved to be a very interesting study on sub-surface soil temperatures. For this purpose one needs pieces of iron pipe cut to desired lengths. In the study described here we used the following lengths: 6″, 12″, 18″, 24″, 30″, 36″. The pipes must be of such a diameter that they accomodate inexpensive thermometers. Holes about the diameter of the pipe are made in the soil with a crowbar to a depth equal to the lengths of pipe. The pieces of pipe are pushed into the holes. The end of a broom handle is used to tamp the earth in the holes so that each pipe is cleared of soil. Strings are attached to each thermometer. The thermometers are lowered into the pipes. A cork or rubber stopper is placed in the open end of each pipe. Temperatures may be read over a period of a day to note variations. Records should be kept during seasonal changes also. This will give some very interesting results

showing wider ranges of temperature near the surface than at greater depths. To further stimulate interest the students should be encouraged to study the literature concerning the relationship of soil temperatures to seed germination, to utilization of nitrogen applied as liquid nitrogen, and to rate of evaporation of soil moisture.

Effect of Water on Soil

The next topic which might be included in a study of soil is the effect of water on soil. Many simple activities have been suggested in the literature. Those of you who are familiar with the work of the U. S. Soil Conservation Service know of the many studies of run-off conducted by the Service. Similar studies may be conducted using improvised equipment. Run-off funnels are constructed of galvanized sheet iron. Pieces of galvanized iron are cut to form the base and roof of the funnel. The overall form of the funnel is shaped like a regular truncated prism. The open ends of the prism have dimensions 36″ x 6″ and 15″ x 6″. The trapezoid-shaped faces which are the top and base of the run-off funnel are 36″ x 37″ x 12″ x 37″. The other two faces are rectangles with dimensions 37″ x 6″. The funnel is put in place at the foot of a slope from which one wishes to measure run-off. To accomplish this the soil is removed to a depth of 4″, the funnel is then put in place in the trench which has been constructed. This leaves a vertical cut in the experimental plot against which the larger open end of the funnel rests.

Water in the form of run-off is collected in large crocks which are placed at the open end of the funnels. One may wish to set up two such run-off funnels. This procedure was followed by the author. In this case two areas were chosen; one with cover, the other devoid of cover. The run-off collected in the two locations was quite different. As you would imagine the amount of run-off and the amount of solid materials which were collected always were greater from the bare plot than from the plot with cover.

Water also acts on soil in another way. Raindrops strike the soil with a great force. You may have noticed this effect on bare soil after a heavy rain. The falling rain not only compacts the soil but at the same time many tiny particles of soil go into suspension. As more rain falls these tiny particles are carried away. So, actually, the falling raindrop is an agent of sheet erosion. Most of you have observed the tiny holes in bare soil made by the falling raindrops. One of the ways in which the effect of these raindrops may be studied is to make what is termed "raindrop impact patterns." One needs pie tins, sand, plaster of Paris and water to complete the demonstration. First punch some holes in the pie tins with a small nail. This, then, provides drainage. The pie tin is filled with sand and placed out-of-doors before a rain storm. After the rain the pan is collected and the raindrop impact patterns are studied. It is possible to make a plaster of Paris cast of the impact patterns by pouring a mixture of plaster of Paris and water over the sand. After the plaster of Paris has hardened the cast is removed and washed. One then has a cast of impact patterns. An interesting comparison can be made if similar impact patterns are collected under various types of cover.

Another simple demonstration shows the difference in water-stability of aggregates of soil. Two small wire baskets or trays are made of quarter-inch wire mesh. The baskets should be large enough to fit into 100 ml. beakers. A clod of soil is collected from a field which has been in row crops for some time. A second clod is collected from a field that has been well managed and on which a grass crop has been regularly included in the rotation. The beakers are filled with water to about three fourths of their depth. A lump of soil from one source is placed in one basket. A lump of soil of about the same size from the other location is put in the second basket. The baskets are lowered into the beakers of water. With a little practice the beakers can be filled to such a level that the lumps of soil will be completely immersed. One will notice that the soil from the field which has been in continuous row crops disintegrates rapidly. It begins to slake and fall through the wire giving a cloudy appearance to the water. The sample from the well managed field, on the other hand, may breakup to the bottom of the glass. However, the water will not appear muddy or cloudy. This of course, indicates a greater resistance to erosion. The latter type of soil absorbs water readily during a rainstorm. Also because these soils do not break up readily they tend to stay in place and are not as sub-

ject to erosion. In this same way one might compare soils from grasslands, meadow crops, and clean cultivated crops.

These are some activities that can be used in teaching about soil in high school biology. Perhaps, with a better understanding of soils we may find greater appreciation of this basic resource.

Lakeview Elementary Pupils Visit the Biology Lab

MARY D. CREAGER
Lakeview High School, Decatur, Illinois

Sometimes in teaching a useful method seems to evolve from a more or less accidental beginning, and so it has been with elementary pupils visting the biology lab at Lakeview High School, Decatur, Illinois. Several years ago I had a few occasions to invite elementary teachers to bring their classes to visit the biology lab during my "free" period. The success of these visits led to further efforts, but it was not until I began teaching at Lakeview that I had an opportunity to more fully develop the program with the help and cooperation of others to be mentioned.

There are 750 students in the junior-senior high school and 1,400 elementary pupils in the district. Of the ninety teachers in the unit there are sixty in the four grade schools.

Two years ago, a second grade teacher from Eldorado School, stopped in the biology lab to chat. I, of course, showed her several specimens, student exhibits, and live plants and animals in the room. Our discussion led to inviting her to bring her second grade for a field trip to the biology lab.

What did the children see in the biology lab? In general, the talks and demonstrations were about the same. Variations were made for differences in grade level and also on recommendation of the visiting teacher, who would give information in advance by telephone or often in the room as to the children's interests and studies. A few biology students assisted in giving demonstrations.

When the children first entered the room, their teacher introduced them. In turn they were welcomed, and attention was directed to the chalk board at the far end of the room. A cardboard cutout of a brightly dressed bird with a cane and hat hung in front of the board. Printed on the board to the left was a welcome note the the group, and in particular, the welcome bird seemed to be saying, "Hello, John Jones," or some youngster's name. Needless to say, the special honor was cause for broad, broad smiles and some discussion. Older children did not openly act so pleased, but reports indicated that each detail of the honor was reported at home.

As the pupils started around the room, a papier maché "bug," the biology club mascot, was on the first desk. This served as an ice-breaker since the children liked to stroke the antennae which caused the eyes to light up and a buzzer to sound. Next, specimens on top of a cabinet would be shown. They might include such things as an ant colony, equisetums, hen's eggs with green yolks, and a tropical butterfly collection.

Two large, lighted display cases furnished information for several minutes. Here the students saw file fish, sea horses, a "little" frog (really a huge bullfrog), Portuguese man-of-war, hermit crab, mouse skeleton, shells, and specimens about which the youngsters asked especially. Often they almost crawled into the case to point out their question. Each animal had a particular story or bit of information that went along with its showing. The big moment came when the hermit crab was removed slowly from his shell, so all could see how he could cling to the shell and why he needed a shell. The youngsters had one stock question repeated over and over, "Is it dead?"

Except for the youngest groups, a biology student demonstrated his microprojector. Then followed a look at the aquarium, bulletin board, and many collections and projects around the room. These had been arranged on the tables and were put away later by biology students.

Next came the climax of the hour when one or two students showed the snakes. In every group some of the children would beg

Tom Straight demonstrated his microprojector made of a coffee can and tracing paper.

Darrell Gelsinger asks, "And—what do you think happened?—The mouse ate the snake!"

In every group some of the children would beg to hold the snakes. Sandra Blair assisting.

to hold the snakes. The prize winning story was told by Darrell Gelsinger whose true story was that a mouse had been put into the snake box in the lab for the snake to eat. "And—what do you think happened—The mouse ate the snake!" Then he would show the children the remaining piece of the snake's tail in a bottle.

By this time only minutes were left, and youngsters were allowed to look around at will, or they could see a demonstration of the human torso model. This, too, was fascination, as breathing, mumps, heart, stomach, and other parts, diseases and functions of the human body were discussed. The children participated by breathing deeply, feeling their heart beats, or raising their hands if they had had a disease mentioned.

Well, there remained much to be told, but it was time for the goodbyes and thanks.

How did the teachers use the field trips for additional teaching? One teacher had her pupils get their books and try to find the animals they had seen. This proved an exciting time for first graders. The children talked about their trip. They wrote stories, asking many questions about facts and spelling. Several teachers used the trip for art work, and the children showed by the detailed information in the drawings that they had observed closely. Spelling was taught by all of the teachers. Many youngsters were encouraged to bring specimens for the room collections or to show to the class. One youngster boldly stated after the visit, "Now that I have been to the high school, I am not afraid to go to the high school to the chili supper!"

The field trips also served as motivation for the biology students whose work was displayed for the pupils in the district. The students that gave demonstrations gained from the experience of preparing and giving their portion of the program. All mentioned that they were nervous for the first few times but overcame much of this. Furthermore, there has been an exchange of materials. The elementary pupils often bring specimens to the lab for displays. Many times the teachers request loans of specimens (up to 30-40), books,

The aquarium always seemed to fascinate the children.

microscopes, cyanide jars, or demonstrations. It is hoped that collections can be built for loan to the elementary teachers for their special units. It should be added here that most of the elementary teachers have well developed "science corners." If the trips accomplish as much as they appear to do, then they are worth the time and energy required for them.

Summer Jobs

Nature-study enthusiasts, science teachers, college girls and graduate students will find hundreds of summer jobs as nature consultants at camps operated by 650 Girl Scout councils throughout the country. To qualify as a nature consultant, a woman must be at least 21 years old, have the required specialized knowledge, based either on formal training in the natural sciences, or on informal personal interest in and study of nature and the out-of-doors. She should also be accustomed to working with young people on a basis of informal give-and-take. Women of 18 years of age can become camp counselors if they have experience in camping and working with children as a leader, teacher or program consultant. Good health, patience and enthusiasm are added requirements. Salaries are determined by the individual's experience, qualifications and training. Women interested in jobs at Girl Scout camps near home should get in touch with the nearby Girl Scout council, listed under "G" in the phone book. For openings in other parts of the country, write directly to: Miss Fanchon Hamilton, Recruitment and Referral Advisor, Girl Scouts of the U. S. A., 830 Third Avenue, New York 22, New York.

Poster Projects

JAMES E. JENKINS
Senior High School, Brazil, Indiana

In biology classes, in a given unit of work, the student should be taught in such ways that they will:

1. Use the tools of science with care and precision.
2. Understand and appreciate the interrelationship of various forms of life and of living and nonliving things.
3. Develop appreciation for the work of scientists.

The student should be helped to think critically along scientific lines and methods of optimum growth of each personality.

The poster project method is flexible so as to help the students study the material resources of their own community. It also increases the range of experiences which constitute the curriculum, for if knowledge does not in some fashion affect the curriculum, then it has no means of entering the bloodstream of education.

Then too, it provides for more active participation by individuals and makes provisions for interested students and above average students to go deeper into the field of science.

We begin our first unit project in September and October by giving each class a separate unit to cover and a separate poster to make which will better aid the six classes of students to understand their unit. For example, the first hour class is given 25 harmful and beneficial insects to collect, name, and mount. The second hour class, 25 wild flowers of Clay County; the third hour class, 25 weeds harmful to yards and fields of grain. Students of the fourth hour class collect weeds harmful to livestock. The fifth hour class studies methods of seed dispersal, and the sixth hour class, hardwoods of Indiana. In this manner each class exchanges their poster projects so that all classes cover their units of study more thoroughly.

Our materials are secured in the following manner. Students are asked to bring old window glass which we trim to the correct size

(Continued on page 133)

An Insect and Leaf Drying Press

GERALDINE V. MARKEN
School No. 234, Baltimore, Maryland

I had heard about insect and leaf drying presses which were used in entomological laboratories but which had never been made for classroom use. Being a primary grade teacher whose classroom becomes cluttered with collections of leaves and insects each year, I believed such a press would prove to be very helpful to my students and me.

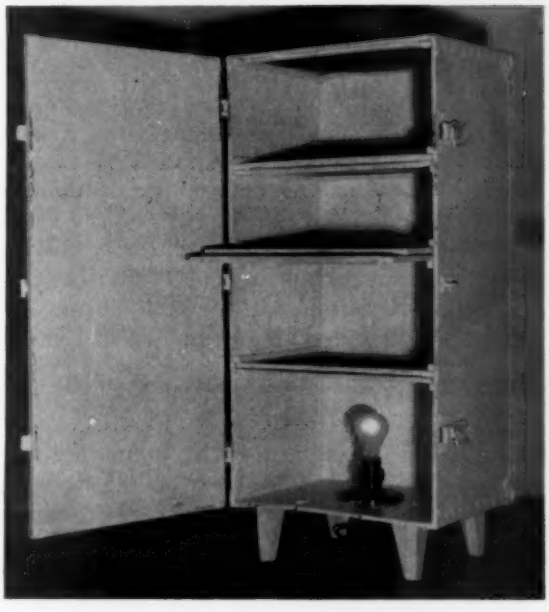
At first I was confused as to what size press I should design. Because those used in the laboratories were supposed to be extremely large, I realized that my design must be made sufficiently small so as to be of practical use for a small classroom. After having thought of using an orange or apple crate, I discovered in my basement the perfect cabinet to use. An old army footlocker proved to be the right size. I stood it upright on one side and discovered that the lid would be a perfect door and that the cabinet could be designed and built within the locker.

The locker was approximately thirty inches high or just the desired height. The depth, 12 inches, and width, 16 inches, proved to be very adequate.

The press would have to be made so that the heat, used in the drying process, would rise from the bottom, pass through the shelf area, and escape out the top. First, I cut a rectangular opening in the top about 8 inches by 12 inches to allow the hot air to escape. This opening was covered with screening to keep out dirt and other foreign matter.

I then designed a shelf area where the leaves or insects would rest while drying. Three shelves, spaced 6 inches apart starting 12 inches from the bottom of the press, seemed to be the desired positions to allow room for placing and replacing without disturbing the operation during drying. The first shelf is far enough from the bulb to avoid burning and the top shelf is close enough to the heat to allow for drying action.

The shelves are made by tacking screening to rectangular shaped wooden frames which slide snugly into the cabinet. Two of these frames placed together screen against screen



Footlocker to Drying Press

provides the apparatus to hold the leaf in place. If they are turned the other way it provides a means of holding the insect in place. The joined shelves are then pushed into the cabinet on wooden runners which hold the shelves tight and in place.

At the bottom of the press is placed a socket in which a bulb is used to supply heat used in the drying process. This bulb should be sixty to seventy-five watts. Around the socket about fifteen one-half inch holes need to be bored to allow a draft to flow upward through the press carrying the heat from the bulb as it goes.

The press has a swinging door which can be opened or fastened tight.

An extension cord allows for freedom of movement around the room. To make the press more attractive, I attached little legs on the bottom. They also serve to allow space for air to supply air draft.

Materials: footlocker, 7 feet of screening, 24 feet of ¼ by ¾-inch wooden strips, light socket, extension cord, unless made with a footlocker (2 hinges, 1 fastener).

Preparation of Kansas High School Teachers of Science

WELDON N. BAKER and MERLE E. BROOKS
Kansas State Teachers College, Emporia, Kansas

The reports of the Southeastern and North Central Conferences on Biology Teaching[1] stressed the importance of improving both the preparation of, and the certification standards for, high school biology teachers. As one step in such improvement, the Kansas State Teachers College of Emporia has undertaken a study of the college preparation of the high school science teachers of the state. The data concerning the teachers were obtained from the High School Principals' Organization Reports for 1955-56, and from the teachers college transcripts, on file in the office of the Kansas State Department of Public Instruction.

The high schools were studied as to enrollment, organization, size of community and size of graduating class. Data on the teachers included age, experience, degrees, teaching subjects, college courses, salary, and size of school from which the teacher graduated.

The data indicate that many Kansas high school biology teachers lack even minimal academic backgrounds. This is due in part to certification requirements which permit anyone who has 24 semester hours of college science, including six of biology, to be a biology teacher, even in a Class A high school. It is due in part to the fact that most of the biology teachers must teach in one, two, or even three other fields. For many of these teachers, biology is only an incidental subject assigned to the individual who happened to have credit in biology, health, agriculture, or other subjects near enough to biology to "meet" the 6-hour requirement. Furthermore, many of the older teachers were certified prior to the establishment of any subject matter requirements.

It was found that 41 of the 539 persons teaching biology (and 86 of the 488 teaching general science) had *no credit at all* in general biology, botany, or zoology. The number who had college credit in general biology was 254, or 47 per cent; botany, 310, or 58 per cent; zoology, 358, or 66 per cent. Only 72, or 13 per cent had credit in any field biology course.

Of these 539 "biology teachers," 368 had taken beginning college chemistry and 240 beginning college physics, but only 147 had taken organic chemistry and only 16 had a course in modern physics.

In the school year 1955-56, 1177 persons taught one or more science courses in grades 9 to 12. Usable data were obtained on 1144 of these. Of the 1144, whose teaching fields were stated in full, 690 taught but one science course. This course was biology in the largest number of cases, 229, followed by general science, 200, Junior High School Science, 98, physics 83, chemistry 59, physiology 11, and various others 10.

A combination of two science courses was taught by 320 teachers. By far the most frequent combination was general science and biology, 143 cases, followed by general science and physics, 32, biology and chemistry, 32, chemistry and physics, 26, general science and chemistry, 19, biology and physics, 17. No less than 51 other combinations, all occurring less than 10 times, were recorded.

One hundred and four teachers had three-science combinations; 50 of these taught general science, biology and either physics or chemistry, 13 biology, physics and chemistry, and 11 general science, physics and chemistry. Thirty other three-science combinations were reported. A combination of four sciences, general science, biology, physics and chemistry, was taught by 19 persons, while 11 taught other four-science combinations. No teacher was reported as teaching more than four different sciences.

Those who teach the high school sciences of Kansas come from all types of colleges. It was found that 444, or 39.2 per cent of the 1139 whose transcripts were complete, held baccalaureate degrees from teachers colleges, 374, or 32.8 per cent from independent colleges, and 321 or 28 per cent, from state and municipal colleges and universities.

[1]Conducted by The National Association of Biology Teachers, on grants from The National Science Foundation, 1954 and 1955; reports published as Vol. 17, No. 1, Jan. 1955, and Vol. 18, No. 1, Jan. 1956, of *The American Biology Teacher*.

The advanced degrees held by the science teachers had equally diverse origins. The 365 Masters degrees held by these teachers were distributed as follows: teachers colleges, 155; University of Kansas and Kansas State College, 106; others (38 schools), 104.

The detailed results of the investigation have been published as Volume 6, Number 2, December 1957, of *The Emporia State Research Studies;* a copy may be obtained by writing the Graduate Office, Kansas State Teachers College, Emporia, Kansas.

Poster Project

(Continued from page 130)

Weeds harmful to livestock

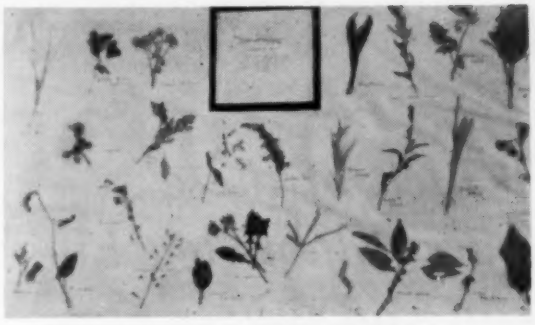
of the boxes we are able to get from clothing stores in town. This material is free.

From our laboratory fee of 25¢ per student for each semester we buy for these projects, 4 rolls of cotton, 2 packages of pins, a bottle of Elmer's Glue-all, 2 boxes of Napthalene moth crystals, and 2 boxes of thumb tacks.

For our other poster we buy pieces of plywood ¼-inch x 20 inch x 30 inch, at 60¢ each, and heaving drawing paper 20 x 30, at 15¢ each. Plasti-glas is used to cover all collections of weeds, leaves, stems, seed, etc. This can be bought by the yard at the Farm Bureau for 69¢ per yard. We use 5 yards for these projects. Tacks are used to pin the glass covering to the board on the back.

The students do all mounting, labeling, printing, and collecting of these items. A committee is chosen in each class of four members who instruct other members on what they need to bring in to complete the poster and unit of study.

These poster units made this year can be set aside and used next year in covering the same unit of study. In this manner every student in class not only has a chance to take part but can contribute something towards his unit of study.



Weeds harmful to gardens

Books for Biologists

ATOMIC ENERGY IN MEDICINE, K. E. Halnan, 157 pp., $6.00, Philosophical Library, Inc., New York, New York, 1957.

The use of radioisotopes has revolutionized many aspects of medical research and diagnosis, and has aided in a growing number of types of medical therapy. This book covers the potential dangers of radiation and possibilities of hopeful treatment by this aspect of atomic energy.

CORTISONE THERAPY, J. H. Glyn, 162 pp., $10.00, Philosophical Library, Inc., New York, New York, 1957.

The author discusses from practical experience the relative values of cortisone, corticotrophin, hydrocortisone, prednisone and prednisolone. The effects of treatment, advantages and disadvantages, indications and contraindications, and the technique of withdrawal are analyzed. The discussion is mainly applied to the rheumatic diseases.

REPTILES, Angus d'A. Bellairs, 195 pp., Hutchinson's University Library, London.

This book deals with the evolution, structure, function and life-history of reptiles, both living and extinct. The first chapters are concerned with the general features of reptilian anatomy and physiology which are common to the class as a whole, while the greater part of the book contains a description of the various major groups. Emphasis is placed on the adaptations of reptiles to different types of environment, and on the means by which they survive and get their living in the world.

PLASTIC SKELETONS, SKULLS Durable, extremely realistic reproductions. Every bone in Clay-Adams plastic skeletons is cast individually in natural color, in mold impressions taken from a normal human specimen. They are easily cleaned, and individual parts may be quickly replaced.

Which of these Clay-Adams teaching aids can you use?

MBH 35 Paramecium caudatum, 65x

MEDICHROMES®

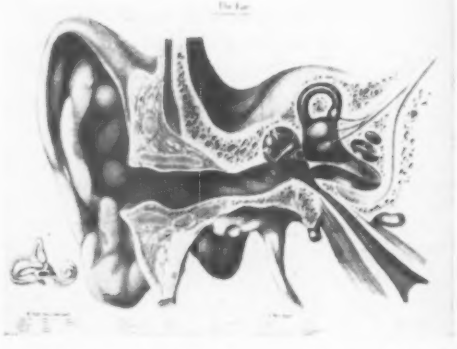
Finest 2 x 2″ Kodachrome presentations, prepared with the cooperation of recognized experts. More than 70 series available, including:

BIOLOGY (Series MBH). 530 slides made with the cooperation of Dr. A. M. Weckstein, Barringer High School, Newark, N. J. Selected to accompany Weckstein-Poster's *"Directed Activities in Biology,"* published by Oxford Book Company.

BOTANY (Series MBT). 103 photomicrographs for instruction in general botany, made with the cooperation of Dr. D. A. Johansen, Pomona, Calif.

ANATOMICAL MODELS

Large scale, anatomically accurate models of the human ear, eye, heart, and other organs are accompanied by detailed descriptive keys. Models are dissectible into component parts for more detailed study. They have been widely used as teaching aids for many years.



ANATOMY CHARTS Frohse, Schick, Michel, Bachin color wall charts of all human organs, systems, structures. Various types of mountings and cases are available.

Also available,
BOTANICAL and ZOOLOGICAL MODELS

PLEASE WRITE FOR
COMPLETE DESCRIPTIONS and prices on these and many other visual teaching aids.

Clay-Adams
141 East 25th Street, New York 10, N. Y.